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VEGETATION TYPES of the SAN BERNARDINO MOUNTAINS

by Jerome S. Horton

VEGETATION
By JEROME S HORTON

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PACIFIC SOUTHWEST
FOREST AND RANGE
EXPERIMENT STATION
BERKELEY CALIFORNIA
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VEGETATION TYPES OF THE SAN BERNARDINO MOUNTAINS, CALIFORNIA

By Jerome S. Horton[1]

Technical Paper No. 44
April 1960

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION

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VEGETATION TYPES OF THE SAN BERNARDINO MOUNTAINS, CALIFORNIA

By
Jerome S. Horton

INTRODUCTION

The mantle of vegetation on mountain slopes plays an important role in the disposition of the rain and snowfall in such areas. Trees, shrubs, herbs, and grasses all consume water. They also add organic matter to the soil, protect the soil surface from erosion, and maintain soil porosity which increases the intake of water. These phenomena must be considered in management of any watershed (Colman, 1953). In a careful study of the hydrology of the San Bernardino Mountains, California [2/], the U. S. Geological Survey (Troxell and others, 1954) asked the Forest Service to prepare a report on the vegetation of the area. The following material was assembled to aid in their study.

The area includes a diversity of environmental conditions, from alpine barrens to desert flats. Fire also has played a large role in determining the vegetation cover. Broadly speaking, the vegetation occurs in three general belts, or areas containing three distinct classes: brush, desert scrub, and forest.

Brush.--A mixture of many brush species, frequently known as chaparral, occurs in the lower altitudes--roughly below 6,000 feet--mostly on the south or coastal side of the mountains and to a limited extent on the north side. The climate in this belt is characterized by hot, dry summers and cool, wet winters. Combined with recurring fires, this kind of climate produces an environment favoring a brush cover.

Desert scrub.--Small trees, shrubs, and subshrubs which thrive on little moisture occur in a belt north of the main axis of the San Bernardino and San Gabriel Mountains at altitudes between 3,000 and 9,000 feet. This desert scrub class is found both in watersheds draining into the Mohave Desert and in those, such as Cajon and Lytle Creeks, flowing through the main mountain axis into the Santa Ana River Valley. It occurs in a climate characterized by deficiency of precipitation.

2/ The area covered in this discussion, includes that portion of the San Bernardino Mountains which drains into the Santa Ana River Valley and the Mohave River, and the eastern portion of the San Gabriel Mountains west to and including San Antonio Canyon.

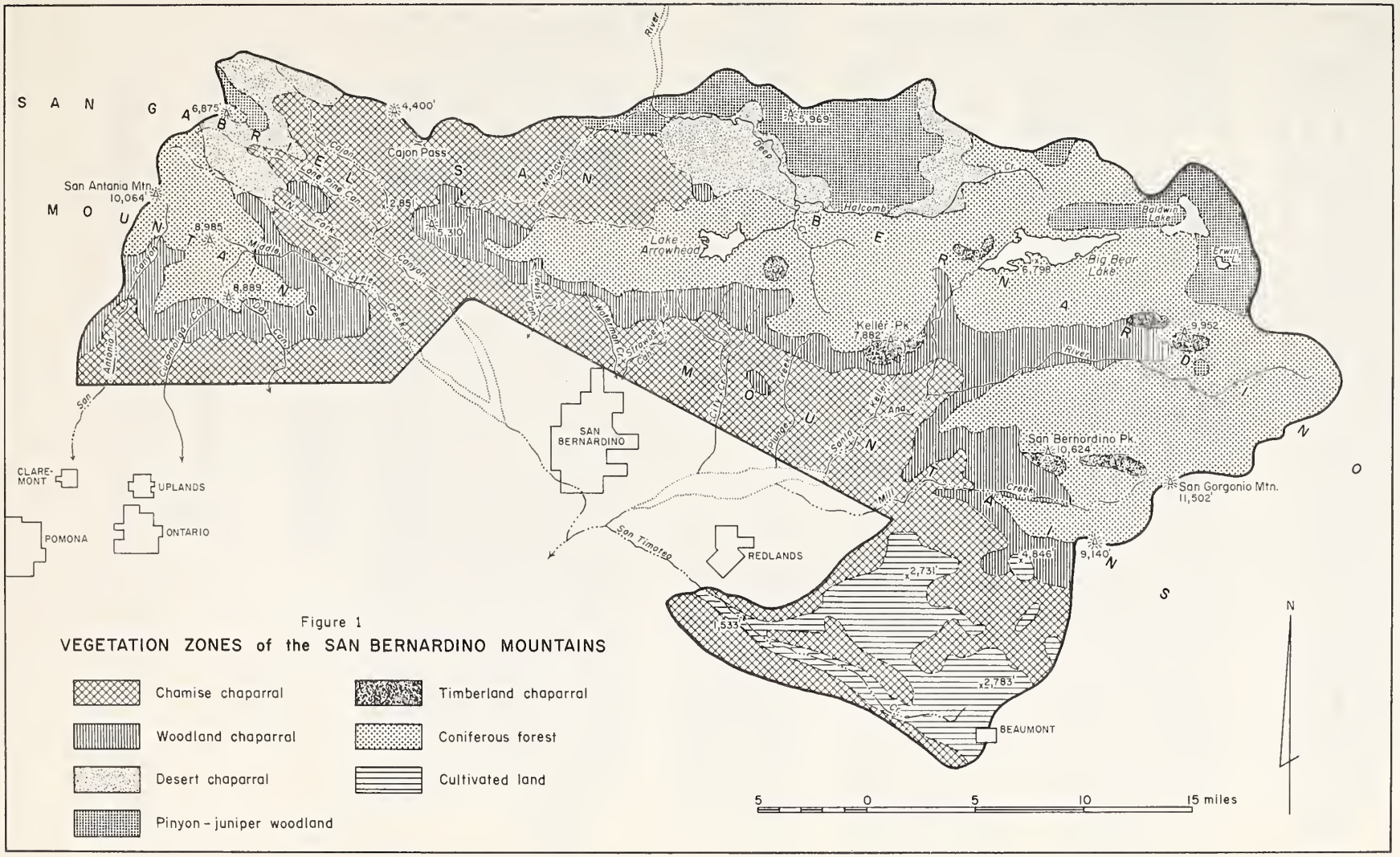

Figure 1

VEGETATION ZONES of the SAN BERNARDINO MOUNTAINS

- Chamise chaparral
- Woodland chaparral
- Desert chaparral
- Pinyon – juniper woodland
- Timberland chaparral
- Coniferous forest
- Cultivated land

Forest.--Coniferous forests, with associated plants, cover the higher altitudes in a belt lying roughly above 6,000 feet. The forest class of vegetation, including some barren alpine slopes and large brush fields, occurs in a climate characterized by cool, usually dry summers and cold, snowy winters.

The factors that determine the kind of vegetation in such rugged terrain as the San Bernardino Mountains vary considerably within each belt of vegetation. In this paper, each belt has been divided into two sub-areas, or vegetation zones (fig. 1). Although the amount of annual precipitation may vary, general climatic conditions are comparatively uniform throughout each zone. The six vegetation zones have been further subdivided into vegetation types--smaller areas in which local variations in topography, soil, fire history, or rainfall have resulted in distinct mixtures of plant species.

In the brush belt the two zones are divided roughly on the basis of altitude. The larger of the two, the chamise-chaparral zone, occupies the altitudes below approximately 4,500 feet and contains five vegetation types. The smaller woodland-chaparral zone occupies altitudes between approximately 4,500 feet and 6,000 feet and consists of four vegetation types. Though made up primarily of brush species, the woodland-chaparral contains many plant species which relate it to the forests of the higher altitudes.

Desert scrub vegetation divides into a desert-chaparral zone consisting of a single vegetation type, and a pinyon-juniper woodland zone with two vegetation types. Pinyon-juniper woodland may be converted to desert chaparral by severe burning because fire eliminates the principal woodland species.

The two zones in the forest belt are: coniferous forest, in which six vegetation types are recognized, and timberland chaparral, which is a single vegetation type. The timberland chaparral type, though made up of brush fields contained within the forest, is designated a separate zone because of the size and economic and ecological importance of the brushfields. It is included in the forest vegetation belt because it has been created in part by destruction of past forests, either by logging and fire or by fire alone. The remaining portions of the timberland-chaparral zone and type occur on sites unfavorable for development of forest cover. Barren alpine areas at the highest altitudes have not been designated a zone because of their limited extent.

Characteristics of the 6 vegetation zones (excluding cultivated land) and their 19 component vegetation types are described in the succeeding pages of this paper. Principal features of each zone are first listed and briefly discussed, and then the differentiating details of each zone's component types are described.

Table 1.--Extent of different vegetation types in the principal drainages of the San Bernardino Mountains, California

Vegetation Zones and Types	San Antonio Canyon	Cucamonga Canyon	Day Canyon	Lytle Creek	Lone Pine Creek	Cajon Creek	Devil Canyon	Waterman Canyon	Strawberry Creek	City Creek	Plunge Creek	Santa Ana River	Mill Creek	San Timoteo Creek	Deep Creek	West Fork Mohave River
	(Percent of watershed area)															
Brush																
CHAMISE CHAPARRAL ZONE:																
Pure chamise chaparral	--	--	--	6.0	40.4	43.8	18.4	8.5	19.6	5.3	---	0.8	--	13.0	0.7	36.7
Chamise-ceanothus chaparral	2.5	11.4	6.5	9.4	--	--	23.1	17.0	2.4	14.3	12.5	4.3	3.2	26.5	--	--
Chamise-manzanita chaparral	--	4.2	--	.9	8.2	18.4	--	--	2.4	7.4	31.2	2.1	7.0	.7	--	--
Scrub oak chaparral	--	5.2	10.9	8.6	14.9	1.8	18.5	21.2	14.6	19.6	18.1	3.5	4.1	.7	--	9.8
Coastal sagebrush	--	--	--	--	--	--	1.5	2.1	--	1.6	--	.1	--	8.1	--	--
WOODLAND CHAPARRAL ZONE:																
Live oak chaparral	10.8	38.6	52.2	1.3	10.4	3.4	18.5	36.3	48.8	39.5	18.8	6.8	17.0	5.3	2.9	2.7
Live oak woodland	1.2	6.3	--	7.7	--	3.9	3.1	--	--	--	1.9	1.1	3.8	.6	.6	1.7
Bigcone Douglas-fir forest	19.0	6.3	10.9	13.8	1.4	1.5	4.6	8.5	4.9	3.2	2.5	2.3	3.5	.9	.1	3.2
Knobcone pine forest	--	--	--	--	--	--	--	--	--	--	2.5	1.4	--	--	--	--
Desert Scrub																
DESERT CHAPARRAL ZONE:																
Desert chaparral	--	--	--	14.5	18.5	18.8	--	--	--	--	--	--	--	--	17.3	1.9
PINYON-JUNIPER WOODLAND ZONE:																
Pinyon-juniper woodland	--	--	--	--	--	1.7	--	--	--	--	--	10.1	--	--	22.0	2.1
Great Basin sagebrush	--	--	--	--	--	4.9	--	--	--	--	--	2.4	--	--	3.7	5.0
Forest																
TIMBERLAND CHAPARRAL ZONE:																
Timberland chaparral	--	--	--	.2	--	--	--	--	--	--	--	3.3	9.0	--	1.2	2.0
CONIFEROUS FOREST ZONE:																
Pine forest	--	--	--	3.3	2.8	1.3	10.8	6.4	4.9	4.8	1.3	32.5	6.0	.3	33.2	22.2
Ponderosa pine-white fir forest	7.0	--	--	4.4	3.4	--	--	--	--	--	3.1	18.2	8.6	--	11.5	4.8
Sugar pine-white fir forest	51.3	28.0	10.8	24.2	--	--	--	--	1.2	--	--	2.7	19.1	.8	4.0	1.4
Grassland	--	--	--	--	--	--	--	--	--	1.1	.6	3.1	--	.8	.5	4.4
Black oak woodland	--	--	--	1.1	--	--	1.5	--	--	3.2	7.5	.1	1.8	1.5	2.3	.5
Alpine forest	6.3	--	--	1.3	--	--	--	--	--	--	--	3.6	13.2	--	--	--
Barren areas	1.9	--	8.7	3.1	--	--	--	--	--	--	--	1.4	3.5	--	--	--
CULTIVATED ZONE:	--	--	--	.2	--	.5	--	--	1.2	--	--	.2	.2	40.8	--	1.6

CHARACTERISTICS OF THE VEGETATION

The boundaries of the vegetation zones shown on figure 1 are necessarily generalized because of the complex topography, which results in equal complexity in vegetation. The extent of the zones and their component vegetation types in each of the 16 principal watersheds of the San Bernardino Mountains is given in table 1. The extent of each type in each watershed is expressed in percent of area above the U. S. Geological Survey stream-gauging station. The areas of vegetation types were determined from vegetation type maps prepared by the Experiment Station, Berkeley, California (3).

A narrow belt of riparian woodland is found along permanently flowing streams in all of the vegetation zones in the San Bernardino Mountains (2). An abundance of moisture throughout the year is the most important environmental factor. Some of the commoner species, such as white alder (Alnus rhombifolia), Fremont cottonwood (Populus fremontii), black cottonwood (Populus trichocarpa), and the California sycamore (Platanus racemosa), occur throughout the mountain mass in the riparian woodlands below 7,000 feet. Various species of willow (Salix spp.) are the most common riparian plants above 7,000 feet. California live oak (Quercus agrifolia), bigleaf maple (Acer macrophyllum), and California-laurel, (Umbellularia californica), occur along the stream channels only in the coastal chaparral zones. No attempt was made to include the area of riparian vegetation in table 1 or figure 1 because of its small extent and its widespread occurrence irrespective of climate. Fires do not usually burn into the riparian woodland.

Some cultivated land occurs in the foothill and valley portions of several watersheds. These areas are included in table 1, but they are given no further consideration.

Nomenclature for the trees is from the 1953 U. S. Forest Service "Check List of the Native and Naturalized Trees of the United States;" for the shrubs, "Illustrated Manual of California Shrubs," by H. E. McMinn.

CHAMISE-CHAPARRAL ZONE

Location. Throughout watersheds of the San Gabriel and San Bernardino Mountains except Deep Creek.

Major vegetation types.

Pure chamise-chaparral
Chamise-ceanothus chaparral
Chamise-manzanita chaparral
Scrub oak chaparral
Coastal sagebrush

Minor vegetation types. Small islands of bigcone Douglas-fir forest, live oak chaparral, and live oak woodland types, which are described later, occur on protected north-facing slopes of this zone.

Altitudinal range. Lower limits, nearly to sea level. Upper limits, north-facing slopes, 3,500 to 5,000 feet: south-facing slopes, 4,500 to 5,500 feet.

Approximate annual precipitation. 13 to 35 inches.

Density of vegetation. Very open to almost impenetrable.

Frequency of fires. Common.

Reaction of vegetation to burning. Fires, through geologic periods, probably have been a major factor in the development of the vegetation of the chamise-chaparral zone. All plants within this zone, except those in canyon bottoms and other places protected from fires, are species adapted to withstand repeated severe burning (6). Many of the shrub species sprout from the stump after burning of the crown. Seeds of other species are stimulated by fire to germinate and produce numerous seedlings.

Erosion after fire. Usually severe in all types of the zone.

Pure Chamise-Chaparral Type

The chamise-chaparral vegetation type is found principally in the areas of low rainfall such as the foothills on the coastal side of the mountains, Cajon Pass, and the West Fork of the Mohave River (fig. 2).

Pure chamise-chaparral is dominated by chamise (Adenostoma fasciculatum), and in only a small part of this type do species other than chamise occur in sufficient numbers or stature to be

Figure 2.--Pure chamise chaparral occurs on the south-facing slope in the foreground. Scrub oak chaparral covers the north-facing slope on the right. Photograph taken in a side canyon of Cajon Creek at 3,000 feet.

Figure 3.--Chamise-ceanothus in Lytle Creek at 3,000 feet has abundant hoary leaf ceanothus in bloom.

Figure 4.--Coastal sagebrush growing on a west-facing slope at 2,400 feet in Lytle Creek illustrates a typical occurrence of this type on colluvial deposits surrounded by chaparral. In the foreground, sagebrush and buckwheat are growing on a sandy alluvial deposit.

important. White sage (Salvia apiana) and other sage species occur in considerable numbers in the foothills from Cajon Pass to Mill Creek. Scattered inviduals of California scrub oak (Quercus dumosa), bigberry manzanita (Arctostaphylos glauca), Eastwood manzanita (Arctostaphylos glandulosa), and other species occur in Cajon Pass and West Fork of the Mohave River. All of these species combined rarely make up more than 25 percent of the vegetation cover. Almost no herbaceous plants are to be found in this type.

The regrowth of a pure chamise-chaparral stand following fire is slow compared to that of the other chaparral types because of the normally slower growth of the chamise shrubs and because of the occurrence of this type on poorer sites. An ephemeral stand of annuals and short-lived perennials comes in immediately after a fire, but these in no way compare with the vigorous herbaceous carpets that often develop after burning of the heavier chaparral types. Crown density of 10-year old pure chamise is about 25 percent in average sites, of 40-year cover about 50 percent, and at 70 years after fire, about 55 percent. Crown density as here used means the percentage of ground which is actually shaded by the vegetation.

At maturity the crowns average from 4 to 8 feet in height, depending upon the site. The litter is very sparse.

Chamise-Ceanothus Chaparral Type

Chamise-ceanothus chaparral is the most widespread vegetation type in the chamise-chaparral zone on the coastal side of the mountains (fig. 3); however, it is not found in Lone Pine and Cajon Creeks, or in the desert drainages; also, it rarely occurs over 4,000 feet in altitude. Chamise-ceanothus chaparral requires more moisture than generally falls in the pure chamise-chaparral type.

This chaparral contains both chamise and hoaryleaf ceanothus (Ceanothus crassifolius) in abundance, and no species of manzanita in appreciable amounts. In some cases chaparral whitethorn (Ceanothus leucodermis) is found instead of hoaryleaf ceanothus. There are occasional individuals of California scrub oak, Christmasberry (Photinia arbutifolia), sugarbush (Rhus ovata), or other chaparral shrubs in addition to the dominant species.

After fire the recovery of a vegetative canopy in this type is more rapid than in pure chamise. This is explained partly by the better site conditions, and partly by the added abundance of the dense-crowned hoaryleaf ceanothus. Ten years after burning, the stands have an average crown density of about 45 percent; at 40 years, 75 percent, and after 70 years, 60 percent. The ceanothus is a short-lived shrub. After about 40 years it begins to die out, and the long-lived chamise gradually assumes dominance. Inasmuch as the chamise never forms as dense a cover as the

ceanothus, there is a gradual decrease in vegetation density as the stand matures.

The height of a 40-year old chamise-ceanothus stand is about 6 to 12 feet, and a fairly heavy litter layer may be formed on the ground. As the vegetation gets older, the amount of litter decreases in consequence of the decrease of ceanothus in the vegetation canopy, although this is compensated in some degree by the decaying wood of the dead ceanothus.

Chamise-Manzanita Chaparral Type

The chamise-manzanita chaparral type is not as extensive as either of the two previously described, but it occurs almost throughout the chamise-chaparral zone above 2,500 feet.

Chamise is always an important dominant in this type. The manzanitas--either Eastwood or bigberry-- may vary from a dense stand to a scattering of individual plants. The area of chamise-manzanita chaparral containing the most Eastwood manzanita is found primarily on the coastal side of the mountains, usually above 4,000 feet. Bigberry manzanita occurs both in Cajon Pass and along the coastal side of the mountains as low as 2,500 feet. The two species may occur together in upper altitudes of their range. Chaparral whitethorn is associated with either species. Hoaryleaf ceanothus may be associated with the bigberry manzanita, especially in the lower altitudes.

Regrowth of the chamise-manzanita chaparral after burning occurs at a rate quite similar to that of chamise-ceanothus, but the density does not decrease as the stand matures.

The crown density of chamise-manzanita chaparral at maturity will vary from open in the Cajon Pass area to dense in the upper altitudes of the coastal slopes. Crown heights at maturity vary from 4 to 15 feet. Litter development is much greater than in the pure chamise chaparral type, but averages somewhat less than in the chamise ceanothus type.

Scrub Oak Chaparral Type

The scrub oak chaparral is found on north-facing slopes throughout the chamise-chaparral zone. It is not important in those parts of this zone that receive less than 20 inches of rainfall annually.

Although California scrub oak is the most abundant shrub of the scrub oak chaparral, mountain mahogany (Cercocarpus betuloides) is commonly associated with it. Occasionally some interior live oak

(Quercus wislizenii), chaparral whitethorn Veatch silktassel (Garrya veatchii), and Eastwood manzanita occur in the upper altitudes of this type. Herbaceous species and subshrubs are usually absent.

Recovery of this vegetation type following burning is rapid because the growing conditions on these protected north slopes are very favorable. All of the common shrubs in this type sprout vigorously from the burned stump. In 10 years, the crown density will normally reach 60 percent; and by 30 years, the canopy will be at a maximum density of 80 percent and a height of 12 feet. As time goes on, the crowns continue to grow until they reach a maximum height of about 20 feet. The litter layer in a mature stand will be 5 or 6 inches deep.

Coastal Sagebrush Type

The coastal sagebrush vegetation type, dominated by low subshrubs, is found primarily in the foothill and valley areas of the chamise-chaparral zone receiving less than 25 inches of rain annually.

The coastal sagebrush, in areas receiving more than 51 inches of rain per year, occurs almost entirely on unconsolidated soil material such as gravel washes, loosely consolidated sediments, talus slopes, and colluvial deposits (fig. 4). In areas where the annual precipitation is less than 15 inches, coastal sagebrush frequently occurs on residual soils, even those formed from the hard igneous rocks.

The dominant species are white sage, California sagebrush (Artemisia californica), California buckwheat (Eriogonum fasciculatum var. foliolosum), and in the eastern portion of the San Bernardino Valley, Incienso (Encelia farinosa). Species such as black sage (Salvia mellifera), southern monkey flower (Diplacus longiflorus), and many other subshrubs, perennials, and annuals are also common. Sugarbush, California scrub oak, hollyleaf cherry (Prunus ilicifolia), or mountain mahogany may occur as large individuals, widely-spaced.

Recovery of this type following burning is rapid, and on the better sites the crown density may be back to maximum in about 10 years after the fire; however, if there has been severe soil loss or if the site is very poor, the recovery will take many years.

The cover at maturity is usually open and does not average over 2 or 3 feet in height. The abundance of herbaceous species in addition to the shrubby species, usually produces a good protective cover for the soil surface except on steep or unstable slopes where the total vegetation frequently covers less than 25 percent of the ground. Throughout the type the litter layer is not well developed.

WOODLAND-CHAPARRAL ZONE

Location. Coastal side of the mountains and to a limited extent in the Mohave River drainages.

Major vegetation types.

Live oak chaparral
Live oak woodland
Bigcone Douglas-fir forest
Knobcone pine forest

Minor vegetation types. Chamise-manzanita chaparral, with a high percentage of chaparral whitethorn, may occur on steep south-facing slopes in the lower altitudes of this zone.

Altitudinal range. Lower limits, north-facing slopes, 3,500 to 5,000 feet; south-facing slopes, 4,500 to 5,500 feet. Upper limits, north slopes, 5,000 to 6,500 feet; south slopes 6,000 to 7,500 feet.

Approximate annual precipitation. 22 to 45 inches.

Density of vegetation. Dense except for open cover on very steep slopes.

Frequency of fires. Common.

Reaction of vegetation to burning. The species which comprise the chaparral type in this zone are as well adapted to withstand burning as those of the chamise chaparral zone. The woodland and forest types, however, contain species less resistant to fire, and consequently these types may be converted to live oak chaparral type by repeated fire.

Erosion after fire. High for a short period. The erosion rate returns to the low normal for this zone within a few years because of the rapid recovery of the vegetation.

Live Oak Chaparral Type

Live oak chaparral is the most prevalent vegetation type throughout the woodland-chaparral zone. It is usually dominated by shrubby individuals of live oak, but in the drier sites associated shrubs of this vegetation type are often most prevalent. The dominant species is most frequently interior live oak. Canyon live oak (Quercus chrysolepis) occurs as scattered individuals throughout, except on the drier slopes.

Woodland stands of canyon live oak will sometimes be converted into live oak chaparral by repeated burning. Any live oak chaparral

Figure 5.--Live oak woodland growing on a north-facing slope. This type is characteristically formed of pure canyon live oak with no appreciable understory vegetation.

Figure 6.--This typical forest of bigcone Douglas-fir is located on a steep north-facing slope at 4,500 feet elevation.

composed primarily of canyon live oak will develop again into a woodland, if protected from fire for a sufficient period. California scrub oak in this type occurs both at lower altitudes where the type merges with the scrub oak chaparral and toward the desert where it merges with desert chaparral. Chaparral whitethorn, mountain mahogany, Eastwood manzanita, and occasionally bigberry manzanita occur abundantly on the drier slopes throughout the live oak chaparral.

Regrowth of the vegetation following fire in this type is rapid. The crown density ten years after burning will be about 50 percent, and by thirty years the crown canopy may be at a maximum density of 70 percent. The height of the canopy varies greatly with the dominant species. Where live oaks are the dominant species, the height may be 12 to 20 feet in thirty-year-old cover. Where the other chaparral shrubs are dominant, the height may be only 6 feet in the same age cover. In both cases, the litter layer is commonly 5 or 6 inches deep.

Live Oak Woodland Type

Live oak woodland occurs most frequently on north-facing slopes of the woodland-chaparral zone. This type covers much less area than the live oak chaparral.

Live oak woodland is dominated by individuals of canyon live oak which are 15 feet or more in height (fig. 5). Scattered trees of bigcone Douglas-fir (Pseudotsuga macrocarpa), frequently occur among the oaks.

This type usually has a more rapid regrowth of vegetation following burning than the chaparral types because of favorable environmental conditions. Also, fires usually leave a considerable portion of trees untouched; and even if the crowns of the canyon live oaks are burned, the stumps sprout vigorously. Under conditions of severe burning, the woodland is reduced to a live oak chaparral type until such time as the stump sprouts reach 15 feet. Wherever the crowns of the trees are destroyed, herbaceous and shrubby plants rapidly develop a dense cover which persists until the canyon live oak sprouts grow large enough to crowd them out. In the deeper soils, the crown density will reach 80 percent by ten years after burning. In shallow soils, the recovery is slower.

The crown density of a mature stand varies from dense to fairly open, depending upon depth of soil and steepness of slope. The height of the canopy varies from 20 to 50 feet, but averages around 30 feet. The litter is deep except on very steep slopes.

Bigcone Douglas-fir Forest Type

The bigcone Douglas-fir forests usually occur on north-facing slopes, whether steep or gentle (fig. 6). These forests are most extensive in the eastern San Gabriel Mountains.

Bigcone Douglas-fir is the most common tree in this forest, but canyon live oak is almost always associated with it in considerable quantity. The number of other associated plants is small, except in altitudes below 4,500 feet where a herbaceous understory may form.

Fires do not usually completely destroy these forests, but each fire that burns into the forest usually removes some mature individuals, kills most of the young trees, and increases the number and density of the chaparral and woodland species in the spaces between the trees. Those portions of the bigcone Douglas-fir forest which are destroyed are replaced by live oak woodland or live oak chaparral and the return of the bigcone Douglas-fir probably requires centuries.

Crown density of the bigcone Douglas-fir forest varies widely from dense to quite open; trees average from 50 to 80 feet in height upon maturity. The litter layer is usually poorly developed because of the scarcity of herbaceous understory and because of the sparse fall of needles from the bigcone Douglas-fir.

Knobcone Pine Forest Type

The scrubby knobcone pine forest is restricted to small areas in City, Plunge and Keller Creeks--the last a branch tributary of the upper Santa Ana River.

The dominant species is knobcone pine (Pinus attenuata), associated with such shrub species as Eastwood manzanita, chamise, chaparral whitethorn, and chaparral pea (Pickeringia montana).

The cones of this species of pine open only after intense heating; thus fire is essential for dispersal of seeds. This pine is usually restricted to sites too poor for development of heavy chaparral. On the better quality sites, the young pine seedlings that might start after a fire cannot compete with the vigorous shrub growth that usually occurs following burning of the chaparral.

Stands of knobcone pine are usually open and are not over 30 to 40 feet in height. The trees are short-lived; they show signs of deterioration and death at about 75 years of age. The litter layer is usually confined to small patches around the bases of the individual trees.

DESERT CHAPARRAL ZONE

Location. Mohave River drainages and Cajon Pass area.

Major vegetation type.

Desert chaparral

Minor vegetation types. Live oak chaparral, pine forest, bigcone Douglas-fir forest, and pinyon-juniper woodland.

Altitudinal range. 3,800 to 7,500 feet.

Approximate annual precipitation. 12 to 25 inches.

Density of vegetation. Open, with over half of the soil surface exposed.

Frequency of fires. Rare because of the open cover.

Reaction of vegetation to burning. The species of this zone usually recover after burning in the same manner as the shrub species of the chamise-chaparral and woodland-chaparral zones.

Erosion after fire. Low because the rainfall is normally deficient.

Figure 7.--Open stand of desert ceanothus growing at 4,000 feet in the Mohave Desert shows a typical admixture of small shrubs and grasses characteristic of desert chaparral.

Desert Chaparral Type

Desert chaparral type occurs uniformly throughout the desert chaparral zone, except where very small islands of live oak chaparral, pine, bigcone Douglas-fir and pinyon types occur on certain slopes protected by topographic conditions from the full severity of the desert climate.

Some of the dominant species of the desert chaparral type occur also in the live oak chaparral type; the separation of these two types of chaparral is principally on the basis of density. The desert chaparral is open, with half or more of the soil surface exposed and unprotected by the shrubs (fig. 7). The reason for this sparse cover is deficiency of moisture available for plant use.

Numerous shrub species are important in the desert chaparral type. Canyon live oak, California scrub oak, mountain mahogany, bigberry manzanita and Veatch silktassel are abundant in the desert chaparral but occur also in the contiguous live oak chaparral. Desert ceanothus (Ceanothus greggii var. vestitus) and California fremontia (Fremontia californica)are common desert chaparral shrubs which do not occur in the live oak chaparral. Many small shrubs and herbaceous plants grow in the spaces between the principal shrubs, but this does not alter appreciably the open character of the cover.

The open character of the vegetation is not conducive to severe burning, although under certain extreme conditions, fires will burn in this type. Regrowth of the vegetation cover following fire is very slow.

The litter layer is confined to patches beneath the large, spreading, more-or-less isolated shrubs.

PINYON JUNIPER-WOODLAND ZONE

Location. Principally in Deep Creek and in the vicinity of Big Bear Lake; also occurs in Cajon Creek.

Major vegetation types.

Pinyon-juniper woodland
Great Basin sagebrush

Minor vegetation types.

Desert chaparral
Live oak chaparral
Pine forest

Altitudinal range. 3,000 to 9,000 feet.

Approximate annual precipitation. 10 to 30 inches.

Density of vegetation. Open, usually over half of the soil surface exposed.

Frequency of fires. Rare because of the open cover.

Reaction of vegetation to burning. The species of this zone are not adapted to withstand burning, except for the associated chaparral shrubs.

Erosion after fire. Low because the rainfall is normally deficient.

Figure 8.--Rocky ridge dominated by an open stand of single-leaf pinyon and scattered western juniper rises from a gentle slope covered with sagebrush.

Pinyon-Juniper Woodland Type

The pinyon-juniper woodland type occurs throughout the pinyon-juniper woodland zone.

This woodland type is dominated by singleleaf pinyon (Pinus monophylla), California juniper (Juniperus californica) or western juniper (Juniperus occidentalis). Singleleaf pinyon occurs throughout the range of the pinyon-juniper woodland except in the driest portions. California juniper occurs in the lower altitudes of the type where rainfall is very low; this juniper may occur as the only woodland species or it may be associated with singleleaf pinyon (fig. 8). Western juniper occurs only in the high altitude portion of the type around Big Bear Lake where it is associated with singleleaf pinyon. Shrubs of the desert chaparral are commonly associated with the pinyon pine except in the Big Bear area. Sagebrush (Artemisia tridentata) and other species of the Great Basin sagebrush type are usually associated with the singleleaf pinyon in the Big Bear area and with the California juniper in the lower altitudes.

Fires burn infrequently through this woodland type. The woodland species are usually killed by burning; the type then is likely to change to the desert chaparral type if shrub species are present or to the Great Basin sagebrush type if the chaparral shrubs are absent.

The cover conditions of the pinyon-juniper woodland are similar to conditions in the desert chaparral zone. The height of these trees varies from 10 feet to 30 feet or, rarely, 40 feet. The litter layer is confined beneath the individual shrubs or trees.

Great Basin Sagebrush Type

The Great Basin sagebrush type occurs throughout the pinyon-juniper woodland zone, but most commonly on gentle slopes and valley floors.

The sagebrush type in the pinyon-juniper zone is dominated by sagebrush, but there are many associated subshrub species such as buckwheats (Eriogonum spp.), rabbit bushes (Chrysothamnus spp.), and sages (Salvia spp.), numerous herbaceous plants, and various grasses. The Great Basin sagebrush type is related to the vegetation of the Rocky Mountains, and therefore does not include many plants common to the coastal sagebrush type.

Because of the open character of the stand, the Great Basin sagebrush is infrequently burned. It is more open than the coastal sagebrush type, even though the sagebrush individuals are larger and more woody than the common shrubs of the coastal type. The litter layer is insignificant.

TIMBERLAND CHAPARRAL ZONE

Location. Throughout the higher mountains; best developed in the eastern portion of the San Bernardino Mountains.

Major vegetation type.

Timberland chaparral.

Minor vegetation types.

Pine
Sugar pine-white fir
Alpine forest types

Altitudinal range. 5,000 to 11,000 feet.

Approximate annual precipitation. 30 to 45 inches.

Density of vegetation. Open to dense.

Frequency of fires. Common.

Reaction of vegetation to burning. All species are adapted to severe burning.

Erosion after fire. Usually not severe, because of large percentage of the precipitation occurs as snow. However, local summer thunder showers may cause considerable erosion if they are centered on the burned area.

Timberland Chaparral Type

The timberland chaparral occurs in the higher altitudes under the same general climatic conditions as the coniferous forest zone--cool to cold temperature and abundant precipitation, mostly snowfall. This chaparral occurs either on steep south-facing slopes or on more gentle slopes where the original forest cover has been removed by logging and fire.

The variant of the type growing on steep south-facing slopes occurs most abundantly on the high peaks of the Santa Ana River and Mill Creek watersheds. Its principal species are mountain whitethorn (Ceanothus cordulatus), Parry manzanita (Arctostaphylos parryana var. pinctorum), and bush chinquapin (Castanopsis sempervirens). On these steep slopes, the type is open--50 percent cover density--and is characteristically composed of large spreading individuals whose crowns do not quite meet. The height of the shrubs is rarely over 4 feet.

Figure 9.--Open forest of Jeffrey pine at Wrightwood (elevation 6,000) shows a vigorous young pine stand developing after selective logging.

Figure 10.--General view of forest and chaparral on the west face of Mt. San Bernardino at an elevation of about 8,000 feet. A forest of white fir and Jeffrey pine occupies the better sites in the center and lower right of the photograph. The higher slopes are dominated by sugar pine and white fir. South-facing slopes are covered with timberland chaparral.

Figure 11.--Windswept alpine forest of lodgepole pine at 8,500 feet on Mt. San Antonio is typical of the exposed slopes at higher altitudes.

In the logged areas, which are principally confined to the moderate slopes of the upper Mohave River drainages, mountain whitethorn, deer brush (Ceanothus intergerrimus), and Parry manzanita are the principal species. The cover in these areas is much denser and may average 6 to 10 feet in height at maturity. A litter layer several inches deep may develop.

Recovery of the timberland chaparral type after fire is much slower than that of the chaparral types of the lower altitude zones, primarily because of the shorter and cooler growing season of these high altitudes.

CONIFEROUS FOREST ZONE

Location. Throughout the San Gabriel and San Bernadino Mountains.

Major vegetation types.

Pine forest
Ponderosa pine-white fir forest
Sugar pine-white fir forest
Grassland
Black oak woodland
Alpine forest
Barren areas

Minor vegetation types. Small islands of bigcone Douglas-fir forest type occur in the lower altitudes. Great Basin sagebrush and pinyon-juniper woodland occur near the boundary with the desert scrub zones. Timberland chaparral type frequently occurs as islands too small to be mapped as timberland chaparral zone.

Altitudinal Range. Lower limits, north-facing slopes, 5,000 to 6,500 feet; south-facing slopes, 6,000 to 7,500 feet. Upper limits, to the tops of the highest peaks.

Approximate annual precipitation. 25 to 50 inches.

Density of vegetation. Dense forest to open barren slopes.

Frequency of fires. Fires are common; but the area burned in individual fires is usually small except where major fires burn from chaparral areas into the forest.

Reaction of vegetation to burning. Single fires do not usually destroy the forest cover, but repeated fires open the stand and tend to convert the forest to timberland chaparral or black oak woodland.

Logging and then burning hastens this process. The mature trees of the dominant conifers, having thick bark, are not usually killed by fire. The young trees, however, are easily burned; and where the mature trees have been logged, the conversion to brush or woodland may be accomplished by a single fire. The forests have been extensively logged only in the headwaters of the Mohave River drainages and in Plunge and City Creek drainages. In some areas this logged forest has been replaced by a vigorous growth of young coniferous trees, but a large percentage has been converted to the non-coniferous types.

Erosion after fire. Usually not severe, because a large percentage of the precipitation occurs as snow. However, local summer thunder showers may cause considerable erosion if they are centered on the burned area.

Pine Forest Type

Extensive pine forests occur in the San Bernardino Mountains and in smaller areas, in the San Gabriel Mountains at altitudes between 5,000 and 8,000 feet.

The pine forests are usually found on rolling sites (fig. 9), but they occur also on steep north-facing slopes. They rarely grow on steep south-facing slopes, which are characteristically covered by the sugar pine-white fir type.

Jeffrey pine (Pinus jeffreyi), and ponderosa pine (Pinus ponderosa) are the most important dominants of this type; but Coulter pine (Pinus coulteri) is common in the headwaters of Deep Creek and Mohave River, and to a lesser extent in those of the Santa Ana River and San Timoteo Creek. Jeffrey pine occurs most frequently above 6,000 feet, and ponderosa pine below that level. California black oak (Quercus kelloggii) is common in open pine forests below 7,000 feet. There is a considerable understory of shrubs, subshrubs, and herbaceous plants.

Pine forests are usually open, but in good sites may be quite dense. The height of the trees varies from 75 feet to 100 feet, or occasionally higher. The litter layer varies with the density of the forest, but is usually several inches deep.

Ponderosa Pine-White Fir Forest Type

The ponderosa pine-white fir forest is the densest forest of the San Bernardino mountains. It is developed only on gentle to moderate slopes with deep soils, at altitudes from 5,000 feet to 8,000 feet. The most extensive areas are in the headwaters of the Santa Ana River and Deep Creek, but it occurs in smaller stands throughout the San Bernardino Mountains.

This forest is dominated by ponderosa or occasionally jeffrey pine, mixed with white fir, (Abies concolor). Sugar pine (Pinus lambertiana), incense cedar (Libocedrus decurrens)and California black oak frequently occur as associates. There is also a wealth of herbaceous species mixed with a considerable understory of shrubs.

The stands are dense, and the height of trees will average 100 feet or more. The litter layer is well developed because of both the density of the cover and the amount of herbaceous and shrub understory.

Sugar Pine-White Fir Forest Type

The sugar pine-white fir, an open forest type, is widespread in the San Gabriel Mountains and is found in the Mill Creek and Santa Ana River watersheds of the San Bernardino Mountains.

The type occurs mostly on south-facing slopes, but is also found frequently on north slopes. The gradients for both exposures are steep, and the soils show considerable active creep. The type ranges in altitude from 5,000 to 8,000 feet.

The forest is dominated by sugar pine, white fir, and jeffrey pine (fig. 10). Canyon live oak and the timberland chaparral species are often associated with the conifers. Practically no herbaceous understory is developed.

Crown density is rarely over 50 percent, and it is sometimes as low as 5 percent. The areas between trees and scattered shrubs are usually bare and unstable, with surfaces of eroding soil, rock slides, or rock outcroppings. No litter layer is developed except in the immediate vicinity of the trees or shrubs.

Grassland Type

Areas dominated by species of grasses or sedges are found on alluvial soils in the forest zone. They are nowhere extensive. Dry grasslands are the most abundant and are composed principally of annual grass species such as Bromus spp. Bunchgrasses and many species of herbs, both annual and perennial, are also found. The scattered wet meadows are dominated by sedges and rushes.

Fires occasionally burn into the dry grasslands, but the damage caused is not comparable to the loss of cover due to overgrazing. No invasion of brush species occurs after fires, perhaps because these grassland soils do not favor shrub development.

Black Oak Woodland Type

Black oak woodland type is common in the altitudes of the forest zone from 5,000 to 7,000 feet, where it usually occupies flat or rolling sites with deep soil. It may occasionally occur on steeper slopes.

The dominant species is California black oak. Associated trees are canyon live oak and conifers, chiefly ponderosa pine and bigcone spruce. The stand is usually open. The trees usually occur as scattered individuals, and the ground between them is occupied by a well developed ground cover of herbaceous species, grasses, and bracken fern. The commonest associated shrub is deer brush. The development of the litter layer varies with the density of the cover and averages from 1 to 4 inches in depth.

A large part of the black oak woodland type was formed as a result of early-day logging of the conifers. The mature conifers were removed, and subsequent burning destroyed young trees. The California black oak, which sprouts vigorously from the burned stump, then became the dominant species wherever it was common in the original forest. In recent years under more intensive fire protection, ponderosa pine is becoming more abundant in the woodland stands.

Alpine Forest Type

A stunted alpine forest occurs above 8,000 feet on the high mountains of the San Bernardino and San Gabriel ranges (fig. 11).

This forest is found on all exposures and on all gradients except the most precipitous. Precipitation, occuring principally as snow, is high, but measurements are lacking for these alpine regions.

Lodgepole pine (Pinus contorta var. latifolia), is usually the commonest dominant. Limber pine (Pinus flexilis), is common above 9,000 feet in the San Bernardino range and occurs instead of lodgepole pine on the highest peaks. Shrub species characteristic of the timberland chaparral occur as isolated individuals almost throughout this forest.

The density of most of the type is less than 50 percent. The trees attain an average height of about 40 feet at the lower altitudes, but on the higher peaks they are so stunted as to resemble shrubs. The litter is sparse and confined to the areas around the bases of the trees or shrubs.

Barren Areas

A barren area is any area which has less than 5 percent of the soil surface protected by vegetation cover. These areas occur principally on the highest peaks of the San Bernardino and San Gabriel ranges, usually above 7,000 feet.

Barren areas are widespread at altitudes above 10,000 feet and sometimes occupy moderate as well as precipitous slopes. Between 7,000 and 10,000 feet the slopes are barren only where they are precipitous or where they are composed of rock talus or rock outcrop.

Frequently the barren areas are too precipitous or unstable to support any vegetation. If there is any cover at altitudes above 8,000 feet, it is composed of stunted or even prostrate trees of limber pine or lodgepole pine and stunted individuals of the shrub species common in the timberland chaparral. Below 8,000 feet, the sparse cover is composed of stunted trees similar in species to the sugar pine-white fir forest type.

Lightning frequently strikes in the barren areas but the trees and shrubs are too widely spaced to allow fires so started to spread from plant to plant.

DISCUSSION

The vegetation of the San Bernardino Mountains is the product of environmental factors in these mountains. The most important of these are moisture, temperature, exposure, gradient, soil, and fire. All are correlated in some degree with topography and altitude.

Moisture.--The amount of moisture available for plant use directly affects the character of vegetation covering any particular site. Throughout the mountains, summer rainfall is almost completely lacking, and all principal species are adapted to this seasonal drought. Other factors being equal, the dominant species and the density of vegetation vary with the amount of winter precipitation. Twenty-five or more inches of annual precipitation under average conditions of soil and topography usually produce a dense vegetation cover. If the average annual rainfall is less than 25 inches, the cover is usually open, and in such areas moisture is probably the most critical factor in determining the vegetation cover.

Temperature.--Temperature affects plant growth in two ways--by influencing the rate of moisture loss from the soil and plants, and by controlling the rate of plant growth. The higher temperatures of the lower altitudes and desert areas increase the rate of evaporation, thus intensifying the effect of the deficient rainfall. As altitude increases, the temperatures become lower, producing in effect successively shorter growing seasons. The range of temperature from the lowest to the highest altitudes of the San Bernardino Mountains is great enough to cause several vegetation belts of quite different dominant species. At approximately 11,000 feet, a "timberline" is reached and the vegetation is reduced to stunted trees and shrubs with some herbaceous plants.

Exposure and gradient.--The exposure, or directional aspect of a slope, influences plant growth primarily through its effect upon temperature. More heat from the sun is received by south-facing slopes than by north-facing ones. This results in a higher evaporation rate and greater water loss on the south slopes. Forests and other vegetation types which are generally believed to require considerable moisture occur at much lower altitudes on north-facing slopes than on south-facing ones. Conversely, desert scrub or other sparse vegetation types characteristic of semi-arid conditions occur on south-facing slopes even though the amount of rainfall may be sufficient for a dense vegetation. The effect of exposure is intensified as gradient increases; that is, insolation becomes greater with steeper gradients on south-facing slopes. Increase of the gradient of a slope also affects plant growth by increasing the surface soil movement, thus increasing the difficulties of plant reproduction and survival (1). If the gradient is steep enough to cause unstable shallow soils, an open cover of vegetation will develop on any exposure.

Soil.--The texture and depth of soil which covers the mountain mass both play an important part in determining the availability of moisture and nutrients. In general, deeply weathered soils with high nutritive value support a denser vegetation cover than shallower or poorer soils on nearby sites subjected to the same precipitation and temperature conditions. Certain vegetation, including most of the chaparral types, can grow upon relatively shallow soil developed from hard underlying rock (5). The sagebrush types, on the other hand, develop best on deep, porous soil or rock materials which are low in nutritive value.

Fire.--One of the most important factors influencing vegetation cover is fire. On the coastal side of the mountains at altitudes below 6,000 feet, a brush cover adapted to repeated burning has been formed through the centuries. The forests at

higher altitudes have always been subject to some fires caused by lightning. Since man's occupation of the mountains, some of these forests have been so logged and burned that they have been replaced by brush or woodland. In the sparse vegetation on the desert side of the mountains, fires are less frequent; but when they do occur, the tree species are usually killed and may be very long in returning.

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